Claims

1. A process for the separation of a synthesis gas comprising hydrogen, carbon monoxide and methane, and possibly nitrogen, by cryogenic distillation, in which:

i) the synthesis gas (1, 5) is purified and cooled down to a cryogenic temperature,

ii) the cooled synthesis gas is separated by a first means (9, 15) in order to produce a liquid depleted in hydrogen (91), the separation carried out by the first means consists of a stage of scrubbing in a scrubbing column (15) with at least a part of the liquid enriched in methane withdrawn from a column for the separation of carbon monoxide and methane having an overhead condenser, the condenser being cooled by a carbon monoxide cycle, and

iii) the liquid depleted in hydrogen is introduced into the upper part of a stripping column (25) which also comprises a lower part,

iv) a gas enriched in hydrogen (27, 29) is withdrawn at the top of the stripping column,

v) a liquid (33) is withdrawn at the bottom of the stripping column and sent to the separation column (45), a gas (43) enriched in carbon monoxide and depleted in methane is withdrawn at the top of the separation column, a liquid (77) depleted in carbon monoxide and enriched in methane is withdrawn at the bottom of the separation column and the gas enriched in carbon monoxide is heated by heat exchange with the synthesis gas from stage i) in order to form a product (29),

vi) a gas (27) withdrawn in the upper part of the stripping column is at least partially condensed and returned at least in part to the upper part of the stripping column, characterized in that the gas withdrawn in the upper part of the stripping column is at least partially condensed in a heat exchanger (23) which also serves to cool at least one gas (210, 211) withdrawn from the scrubbing column, the heat exchanger also serving to heat a refrigerant.

2. The process as claimed in claim 1, in which the gas (27) withdrawn in the upper part of the stripping column condenses against at least a part (51) of the carbon monoxide cycle liquid.

3. The process as claimed in either of the preceding claims, in which the synthesis gas (1, 3) comprises nitrogen and the liquid withdrawn from the stripping column (25) or a fluid derived from this liquid is separated in a denitrogenation column (55), the liquid of which serves to at least partially condense the overhead gas from the stripping column.

4. The process as claimed in one of the preceding claims, in which the gas (27) withdrawn in the upper part of the stripping column is at least partially condensed by heat exchange with a liquid enriched in carbon monoxide withdrawn from the separation column (45), which heats up and optionally vaporizes, at least partially.

5. The process as claimed in claim 4, in which the liquid (47) enriched in carbon monoxide is withdrawn from a distillation section of the separation column (45) or from a capacity forming the top of the separation column.

6. The process as claimed in one of the preceding claims, in which the gas withdrawn from the upper part of the stripping column (27) is an overhead gas from the stripping column withdrawn at a level above any heat and mass transfer means of the stripping column.

7. The process as claimed in one of claims 1 to 6, in which the gas withdrawn from the upper part of the stripping column is withdrawn at least one theoretical plate below the top of the stripping column, a part of the liquid enriched in methane withdrawn from the separation column being sent to a level of the stripping column above the level for withdrawal of the gas.

8. The process as claimed in one of claims 1 to 6, in which the separation carried out by the first means does not comprise a stage of washing with a liquid enriched in methane.

9. The process as claimed in one of the preceding claims, which is kept cold by a cycle using the gas enriched in carbon monoxide originating from the separation column (45).

10. The process as claimed in one of the preceding claims, in which the liquid (17) depleted in hydrogen contains between 1 mol% and 3 mol% of hydrogen.

11. An apparatus for the separation of a synthesis gas comprising hydrogen, carbon monoxide, methane and optionally nitrogen by cryogenic distillation comprising a heat exchanger (7), a first separation means (9, 15) which is a methane scrubbing column, a stripping column (25) and optionally a column for the separation (45) of carbon monoxide and methane, means (3) for purifying the synthesis gas, means for sending the purified gas to be cooled in the heat exchanger to a cryogenic temperature, means for sending the cooled synthesis gas to the first means for producing a liquid depleted in hydrogen (17), means for introducing the liquid depleted in hydrogen into the upper part of the stripping column which also comprises a lower part, means for withdrawing a gas enriched in hydrogen (27) at the top of the stripping column, means for withdrawing a liquid (33) at the bottom of the stripping column, a second heat exchanger (23), means for sending there a gas (27) withdrawn in the upper part of the stripping column and means for sending at least a part of the gas at least partially condensed in the second heat exchanger to the upper part of the stripping column, means for sending the stripping column (25) bottom liquid (33) to the column for the separation of carbon monoxide and methane (45), means for withdrawing a gas (43) enriched in carbon monoxide and depleted in methane at the top of the separation column, means for withdrawing a liquid (77) depleted in carbon monoxide and enriched in methane at the bottom of the separation column and means for sending the gas enriched in carbon monoxide

to heat up in the heat exchanger by heat exchange with the synthesis gas in order to form a product, characterized in that it comprises means for sending at least one gas (210, 211) withdrawn from the scrubbing column to be cooled in the second heat exchanger and means for sending at least one refrigerant to heat up in the second heat exchanger.

12. The apparatus as claimed in claim 11, in which the second heat exchanger is an indirect heat exchanger (23).

13. The apparatus as claimed in claim 11 or 12, comprising means for withdrawing the gas in the upper part of the stripping column and for sending it to condense against at least a part of the carbon monoxide cycle liquid (47, 51).

14. The apparatus as claimed in claim 11, 12 or 13, where the refrigerant is a liquid (47, 51) enriched in carbon monoxide and comprising means for withdrawing the liquid enriched in carbon monoxide is from a distillation section of the separation column or from a capacity forming the top of the separation column.

15. The apparatus as claimed in one of claims 11 to 14, in which the means for keeping the process cold comprise a cycle (47, 51, 57, 67) using the gas enriched in carbon monoxide originating from the separation column.

~~AMENDED~~ CLAIMS

~~Received by the International Office on July 1, 2019 (01.07.2019)~~

1. A process for the separation of a synthesis gas comprising hydrogen, carbon monoxide and methane, and possibly nitrogen, by cryogenic distillation, in which:

i) the synthesis gas (1, 5) is purified and cooled down to a cryogenic temperature,

ii) the cooled synthesis gas is separated by a first means (9, 15) in order to produce a liquid depleted in hydrogen (91), the separation carried out by the first means consists of a stage of scrubbing in a scrubbing column (15) with at least a part of ~~the~~ a liquid enriched in methane withdrawn from a column for the separation of carbon monoxide and methane (45) having an overhead condenser, the condenser being cooled by a carbon monoxide cycle, and

iii) the liquid depleted in hydrogen is introduced into ~~the~~ an upper part of a stripping column (25) which also comprises a lower part,

iv) a gas enriched in hydrogen (27, 29) is withdrawn at the top of the stripping column,

v) a liquid (33) is withdrawn at the bottom of the stripping column and sent to the ~~separation~~ column for the separation of carbon monoxide and methane (45), a gas (43) enriched in carbon monoxide and depleted in methane is withdrawn at the top of the ~~separation~~ column for the separation of carbon monoxide and methane, a liquid (77) depleted in carbon monoxide and enriched in methane is withdrawn at the bottom of the ~~separation~~ column for the separation of carbon monoxide and methane and the gas enriched in carbon monoxide and depleted in methane is heated by heat exchange with the synthesis gas from stage i) in order to form a product (29),

vi) a gas (27) withdrawn in the upper part of the stripping column is at least partially condensed and returned at least in part to the upper part of the stripping column, characterized in that the gas withdrawn in the upper part of the stripping column is at least partially condensed in a heat exchanger (23) which also serves

to cool at least one gas (210, 211) withdrawn from the scrubbing column, the heat exchanger also serving to heat a refrigerant.

2. The process as claimed in claim 1, in which the gas (27) withdrawn in the upper part of the stripping column condenses against at least a part (51) of ~~the~~ a carbon monoxide cycle liquid.

3. The process as claimed in either of the preceding claims, in which the synthesis gas (1, 3) comprises nitrogen and the liquid withdrawn from the stripping column (25) or a fluid derived from this liquid is separated in a denitrogenation column ~~(55)~~, the liquid of which serves to at least partially condense ~~the~~ an overhead gas from the stripping column.

4. The process as claimed in one of the preceding claims, in which the gas (27) withdrawn in the upper part of the stripping column is at least partially condensed by heat exchange with a liquid enriched in carbon monoxide withdrawn from the separation column (45), which heats up and optionally vaporizes, at least partially.

5. The process as claimed in claim 4, in which the liquid (47) enriched in carbon monoxide is withdrawn from a distillation section of the separation column (45) or from a capacity forming the top of the separation column.

6. The process as claimed in one of the preceding claims, in which the gas withdrawn from the upper part of the stripping column (27) is an overhead gas from the stripping column withdrawn at a level above any heat and mass transfer means of the stripping column.

7. The process as claimed in one of claims 1 to 6, in which the gas withdrawn from the upper part of the stripping column is withdrawn at least one theoretical plate below the top of the stripping column, a part of the liquid enriched in methane withdrawn from the separation column being sent to a level of the stripping column above the level for withdrawal of the gas.